

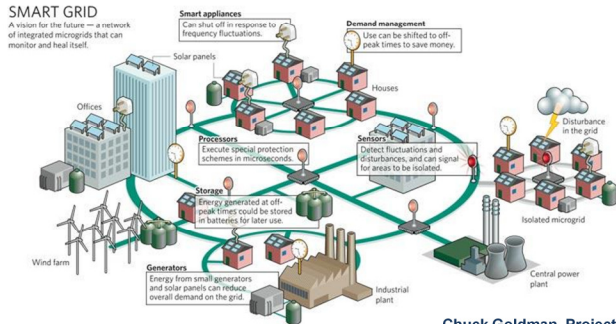
An Introduction - Smart Grid 101

Chapter 13: Implementation Transition Planning



SMART GRID

A vision for the future—a network of integrated microgrids that can monitor and heal itself.



Chuck Goldman, Project Manager
Electricity Markets and Policy Group
Lawrence Berkeley National Laboratory

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Severin Borenstein
E.T. Grether Professor of Business
Administration and Public Policy,
Haas School of Business

Ron Binz
Principal, Public Policy Consulting
Former Commissioner,
Colorado Public Utilities Commission

University of California Berkeley Boalt Hall School of Law

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The Smart Grid is a compilation of concepts, technologies, and operating practices intended to bring the electric grid into the 21st century. Smart Grid concepts and issues are difficult to address because they include every aspect of electric generation, distribution, and use.

While the scope of smart grid covers the entire utility system from generation to how customers use energy, this chapter addresses the topic of demand response.

Our objective throughout this chapter is to more clearly define demand response, to point out policy, technology, and customer behavior combine to define the capabilities and potential benefits of Smart Grid.

*Note:

The original slides were developed for a Webinar delivered on June 10, 2011. Much of the material in the June Webinar was based on a Proposed Decision from the California Public Utilities Commission (CPUC), which was considered the first, comprehensive regulatory decision to address smart grid privacy issues.

On July 29, 2010 the CPUC issues a Final Decision to close out their Privacy Proceeding. The notes to this slide deck have been updated to reflect the final decision. The Final Decision made substantial changes in the CPUC jurisdiction over customer data and privacy.

The organizers consider the differences between the Proposed and Final Decisions significant, consequently in many cases the notes to these slides present both interpretations. Proposed decision notes are presented in 'normal' black colored font. Final Decision changes are presented in "blue" colored font.

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The contents of this chapter are divided into six sections.

- As with our prior webinars and chapters, we start with a narrow set of objectives and try to focus on attention on demand response (DR) issues principally related to regulatory policy.
- Section 4 provides updated information on the two principal NIST standards efforts related to DR.

Objective



This webinar will begin an examination of key policy issues that lay the foundation for smart grid implementation and provide the basis for engaging customers .

- ☐ How do you engage customers and unlock the potential for Smart Grid benefits?
- ☐ How do we transition our customers from where they are today to where they need to be tomorrow?
- ☐ Which is the best approach: opt-in or opt-out?
- ☐ Are there implementation options that allow us to identify potential problems before they occur, take corrective actions and avoid a customer revolt?

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This webinar highlights key policy dynamic rate implementation issues. Dynamic rates and the prices they communicate provide a fundamental component of smart grid, however there is little consensus and until now few options to guide how commissions transition from today's rates to the dynamic rates necessary to support smart grid. Dynamic rates and the price variation they can provide are necessary to:

- reflect the time varying costs of utility services,
- provide customers with economic incentives to shift or control loads to mitigate peak usage
- Justify customer participation and investment in demand response automation equipment, and
- provide economic incentives to support electric vehicles, storage, and renewable energy options.

There are many key impediments to the implementation of dynamic rates, including the potential for adverse bill impacts and lack of technology to automate customer response. The current customer complaints and problems with smart meters highlight the need to Even more critical are basic customer engagement issues, such as: (1) should dynamic rates be offered on an opt-in or opt-out basis or should they be mandatory for a limited segment of the customer base; (2) if customers are allowed to opt-out, how should alternative rates be structured and what costs should they include, and; (3) what options are there to better educate and engage customers and how can they also be used to identify and mitigate potential problems?

This webinar will address each of these questions.

Speakers



Severin Borenstein

- ❑ E.T. Grether Professor of Business Administration and Public Policy at the Haas School of Business
- ❑ Co-Director of the Energy Institute at Haas.
- ❑ Director of the University of California Energy Institute.
- ❑ Research Associates of the National Bureau of Economic Research in Cambridge, MA.

Current research includes the economics of renewable energy, economic policies for reducing greenhouse gases, equity and efficiency effects of electricity pricing, and competitive dynamics in the airline industry.



Ron Binz

- ❑ Consulting, specializing in energy and telecommunications economics and policy issues.
- ❑ Senior Policy Advisor at the Center for the New Energy Economy at Colorado State University.
- ❑ Former Chairman of the Colorado Public Utilities Commission.
- ❑ Member of the Harvard Electricity Policy Group and the Keystone Energy Board.
- ❑ Recently served on the Advisory Council to the Electric Power Research Institute (EPRI).

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The speakers for this webinar are Severin Borenstein and Ron Binz. Refer to Slide #1 for expanded bios and links for each speaker.

Equitable and Efficient Adoption of Opt-In Residential Dynamic Pricing

Severin Borenstein

University of California Berkeley Laboratory - Severin GRII Technical Advisory Project

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- While dynamic pricing would be most effective as a default option for most customers, political, regulatory, and consumer issues make optional or opt-in a more likely implementation candidate.
- The discussion the follows addresses a residential opt-in approach that is structured to be more politically acceptable and achieve most of the efficiency gains and other benefits that dynamic pricing has to offer.



Barriers to Acceptance of Dynamic Pricing

- Mandatory tariff
- Fair treatment of customers who opt out
- Concern if mistakenly choose dynamic price
 - “Bill shock”
- Concern of bill volatility under dynamic price
- Impact on low-income customers
- Dealing with increasing-block pricing

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There are a number of barriers to dynamic pricing and some of them have to do with smart meter health, safety, privacy, and cost. I'm going to talk about barriers to dynamic pricing itself. One of the leading barrier to dynamic pricing appears to be an approach that mandates dynamic pricing. However, regulators and customers are also concerned that:

- customers will be treated unfairly because they would prefer to be on a flat rate
- Some may choose to be on a dynamic price but have a load pattern that increases their bill
- Customers are concerned that dynamic pricing will cause bill volatility and create circumstances that make budgeting and bill payment difficult
- There is also concern that low income customers will be adversely impacted and pay a lot more, and
- Increasing block-pricing, which many consider critical to achieving efficiency objectives can't be integrated with dynamic pricing.

The material the follows will propose options that mitigate all of these concerns.



Opt-in dynamic tariff with budget neutrality by tariff choice group

- First, establish a dynamic tariff that would be revenue adequate if it were applied to ALL residential customers
 - Cost-based pricing, but doesn't need to match costs exactly
 - Still room for recovering fixed and sunk costs
- Offer cost-based dynamic tariff as opt-in
- Offer a flat rate that is the weighted average rate of the dynamic tariff with weights from the load profile of those who do not opt in
- All tariffs based on the same cost structure

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The fundamental idea behind the basic proposal being recommended addresses:

An Opt-in dynamic tariff with budget neutrality for the group that opts-in and the group that does not opt-in.

Under this proposal everyone will pay their fair share.

- The group that opts-in will pay their fair share by paying a dynamic rate.
- The group that does not opt-in will pay under a flat rate that covers all costs of this group.

Dynamic tariff for this discussion includes critical peak pricing or real-time pricing or even time-of-use pricing.

1. First establish a dynamic tariff that is revenue adequate, assuming all customer participate - customers will be on the tariff, and reflects all costs.
2. Then offer this tariff to all customers. Some will choose to be on this dynamic tariff and some will not. Now the question becomes, what is each group actually charged?
3. With advanced interval metering, the load data will be available to establish the aggregate load profile for each of these customer groups. For the group that chooses not to sign up, their actual load profile can be used to allocate their costs and develop prices that reflect this groups pooled average costs.

Establishing these two groups of customers is somewhat equivalent to customers making decisions to purchase insurance. Some people choose to not buy insurance, in which case they face the actual events and associated costs (dynamic rate group). Some people want to be insured and not face the costs of each individual event, but as a pool they cover their costs in aggregate (flat rate group).



Example of revenue neutrality for default tariff group

- Set dynamic tariff to reflect cost recovery
 - Off-peak: \$0.10, Peak: \$0.30, Critical Peak: \$1.00
- Allow customers to opt in or not
- Calculate or estimate load profile of customer group choosing to remain on default flat rate
 - Off-peak: 85%, Peak: 12%, Critical Peak: 3%
 - Weighted average price is
 $0.10 \times 0.85 + 0.30 \times 0.12 + 1.00 \times 0.03 = \$0.151/\text{kWh}$

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13:10

This example illustrates the calculations to establish a revenue neutral tariff for the default flat rate group who choose to not take the dynamic rate option.

For simplicity purposes we've assumed that this group of consumers consume 85% of their power off-peak, 12% on peak, and 3% during the critical peak. The flat revenue neutral default rate would just be the mathematical computation illustrated in the second bullet which weights each dynamic period price by the appropriate usage shares.

For this example, the flat price or group weighted average price would be \$0.151 / kWh. This is the price that would be charged to the group that does not opt-in.



Implementation of default flat rate

- May start with all customers opting out, so flat rate is system average price
- After customers opt in to dynamic tariff, reset flat rate to reflect weights from load profile of customers remaining on that rate
- Selection effect means cheaper load shapes choose dynamic rate, which raises flat rate
- Price response means opt-in customers reduce peak consumption, which increases system efficiency and lowers flat rate
- In short run, probably net increase in flat rate

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13.40

If all customers opt-out the default rate becomes the system average price. But as customers opt-in the rate would be changed to reflect the change in usage shares and weights of each group by rate period of those that opt-in. The people who choose to not opt-in will most likely be those with peakier load profiles

There will be a selection effect. Customers with flat rates will most likely be the first to opt-in because they will immediately benefit from the dynamic prices. As these customer opt-in to the dynamic rate the weights for the default group will need to be reset, which will raise the average price for the default flat rate group.

Some of the customers that opt-in to the dynamic rate will reduce their peak consumption consistent with the dynamic rate. In the short run response to the dynamic rate will increase system efficiency and correspondingly lower the bills for the opt-in group. In the long-run, response to the dynamic rate will also lower the flat rate as well. In the short-run there will probably be a net increase in the flat rate, although that increase will probably be very small.



Shadow bills to keep customers informed of all options

- Every bill shows actual payment under chosen tariff and alternative payment that would have occurred under alternate tariff
- Shadow bill for last billing period and for last 12 months to address seasonal fluctuations
 - Different info for recent move-ins
- Shadow bill shown for both customers on flat and customers on dynamic rate

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15:00

One way to gain acceptance of this approach is to be completely transparent about what's going on. Shadow billing for every bill could include not only what you owe for the tariff you are on but the bill for what you would have owed for the alternative tariff. The use of shadow bills should go both directions. So customers on the dynamic tariff would get a shadow bill that itemizes what they would have paid on the flat rate and customers on the flat rate would receive a shadow bill that itemizes what they would have paid on the dynamic rate. Shadow bill provided in this manner would provide customers with information to make them fully aware of what rate they were actually on as well as what their alternative would be. Customers should also be provided with a 12-month lag basis that would show what they would have paid in aggregate over the preceding 12-month period. This information would have the effect of smoothing out potential seasonal differences.

This shadow bill approach would provide full transparency as to customer choices.



Addressing bill volatility under dynamic pricing

- Effect is much smaller under CPP than RTP
- Very little annual volatility difference between CPP and flat, but larger monthly fluctuations
- Increased volatility is mostly predictable
- Option for reducing bill volatility with pre-purchase of summer peak power
- “Snap Credit” is alternative to level pay plans
 - Instant load offer when bill is abnormally high
 - Still get bill for full amount, but option to defer pay

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16:20

There are issues of bill volatility. The empirical section of this presentation will provide more information on the magnitude of that volatility.

There are several options to address bill volatility. Besides the common option which is to sell a forward contract, where the customer can purchase some of their power in advance at a fixed price, there is another idea that should be considered. For customers that have very high bills there should be consideration for an ‘instant credit’ or ‘snap credit’. Rather than a level payment plan that hides the bill variation the ‘snap credit’ would automatically offer the consumer a temporary loan that could be applied to address seasonal or other bill volatility. Under this approach the customer would still see the bill and would have to make a conscious decision to take out the loan. This approach should increase the salience of this rate approach.



Impact on low-income customers

- Would they be harmed disproportionately by dynamic pricing if every customer makes their best choice among tariffs?
- How large is the risk from making the wrong choice?
- Will any low-income customers be made worse off? Inevitably, yes
- Can low-income targeted programs protect that group of customers?

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17:07

There are some serious questions concerning potential bill impacts on low-income consumers. Empirical work has been completed using data from California that looks at bill impacts on various consumer groups, which will be presented in the next few slides.

Several of the key questions are provided in the bullet points on this slide. The first two questions will be addressed later. The answers to the last two questions are in the bullet points, specifically:

- Will any low-income customers be made worse off? Inevitably, yes
- Can low-income targeted programs protect that group of customers?



Empirical investigation of load shapes and impact of Critical Peak Pricing

- PG&E load research data, hourly data on 859 to 1034 premises over 2006-2009
- Data include region, consumption, tariff, service type (e.g., electric heat), and load
- Know census block group, but not address
- Assume a system wide flat rate (\$0.16) and create a CPP that is revenue-neutral over 4 years for total load shape
 - Assume zero elasticity, include all customers

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17:27

The empirical work is based on data from Pacific Gas & Electric Company as well as Southern California Edison. Results from both utilities are quite consistent. Features of the data sets are described in this slide. The data sets represent information similar to these utility load research data used for constructing class load profiles.

While the data sets don't identify the income of associated with the customer load data, we did have census block location data which was used to do a statistical match expected income.

For the empirical analysis the last bullet point describes the key rate and elasticity assumptions being modeled.



Impact of Alternative System wide Tariffs

	Winter Off-peak	Winter Peak	Summer Off-Peak	Summer Part-Peak	Summer Peak	Summer Critical-Peak
Flat Rate	\$0.160	\$0.160	\$0.160	\$0.160	\$0.160	\$0.160
TOU	\$0.120	\$0.133	\$0.120	\$0.200	\$0.399	\$0.399
CPP	\$0.111	\$0.123	\$0.111	\$0.185	\$0.370	\$1.000
Effective	Nov-Apr all other winter hours	Nov-Apr Mon-Fri 5pm-8pm except holidays	May-Oct all other summer hours	May-Oct Mon-Fri 10am-1pm & 7pm-9pm except holidays	May-Oct Mon-Fri 1pm-7pm except holidays and CPP days	May-Oct M-F, 1pm-7pm 15 days of max demand of summer

- Calculate monthly bills of each customer under each tariff
- Look at distribution of winners and losers under switch to TOU or CPP
- Look at impact on bill volatility

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18:46

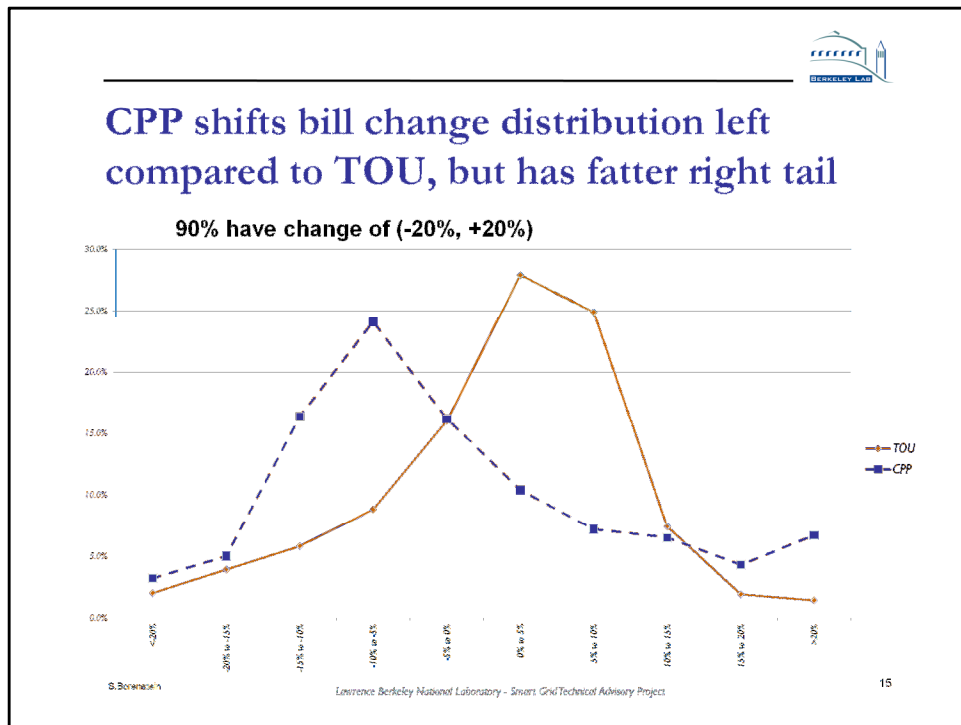
Bill impacts were estimated by using three alternative tariffs which were then applied against the PG&E and SCE data sets. The three tariffs included:

- (1) a flat rate with a constant per kWh charge in all seasons and time periods
- (2) a TOU rate with a peak and off-peak, with a higher summer peak rate
- (3) a Critical Peak rate with a peak, off-peak and critical summer peak price, which is set at \$1

Question: How do you recover capacity costs in the rates:

They can be recovered by averaging them in with the basic rate. This is similar to what is now done with most rates. The distortion is not very significant.

For this analysis, monthly bills were calculated for each consumer under each of these rates assuming no price response. This approach throws away the potential advantages of a rate and just looks at the distributional impacts of each rate on a customer bill. In essence this approach allows us to look at a potential worst case assessment of bill volatility.

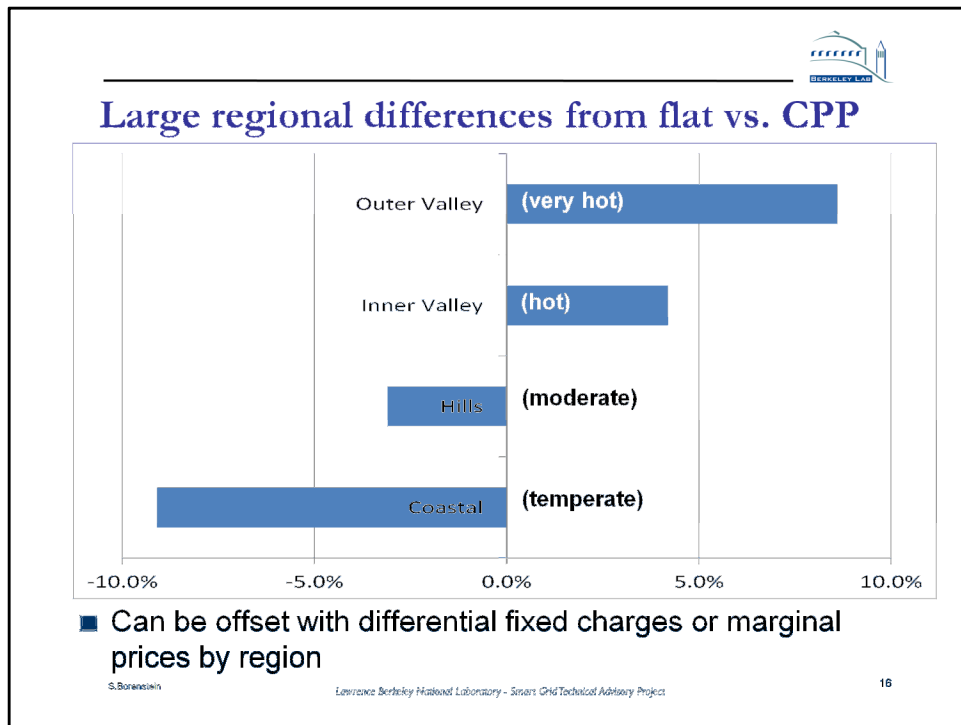


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This graph shows the distribution of the change in monthly bills from a flat rate. The blue dashed line shows a change from a flat to a CPP tariff, while the pale yellow line shows the distribution of change in bills from a flat rate to a TOU.

In both cases about 90% of all customers have increases or decreases in their monthly bills of less than 20%. For TOU rates approximately 95% of the customer exhibit changes plus or minus 20% from the flat rate.

With CPP, a larger share of customers actually experience reduced bills and save money, however the right tail of the distribution is fatter, which means that a larger share of customers actually see their bill increase by more than 20%.

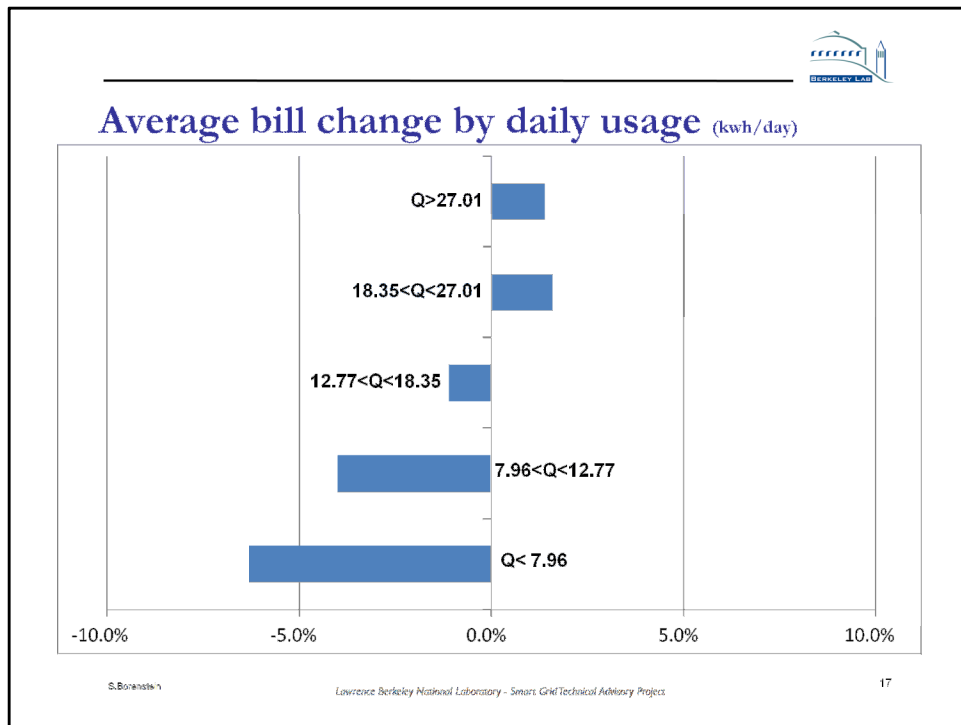


22:18

There are big regional differences between the SCE and PG&E service territories. This graph illustrates some of the differences within the PG&E territory, ranges from the coast all the way through the inland valley.

Changing from a flat to CPP rate would impact PG&E customers differently depending on where they live. Customer along the coast would see a bill savings of about 8%, which those in the inner and outer inland valley might see 4-8% bill increases.

If these types of bill impacts are politically unacceptable, it is relatively easy to address this issue by changing the price levels regionally. We aren't advocating this because we believe that prices should reflect differences in costs, however different rates could be applied to different regions.

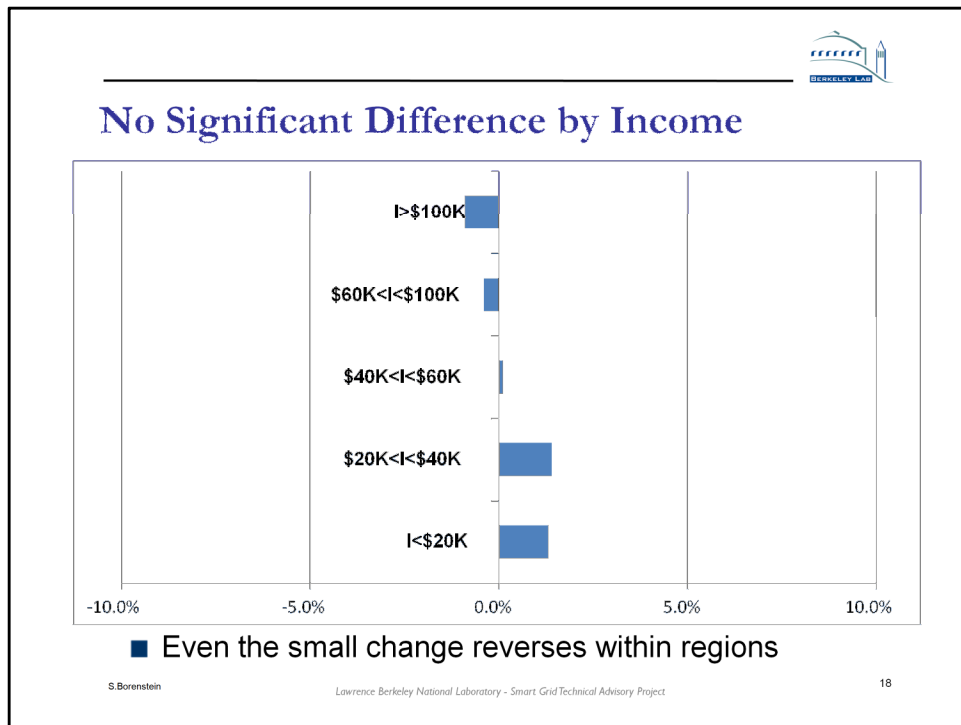


23:28

High use customers would generally pay more under a CPP rate than under a flat rate.

This graph illustrates how each of the quintiles across the entire population of customers would fare under a change from a flat to CPP rate.

The bill change for all high use customers, represented by the two upper most bars, show that they would pay on average about a 2% increase over a flat rate. Low use customers, represented by the two lower bars would save on average about 4-6% over what they might pay on a flat rate.



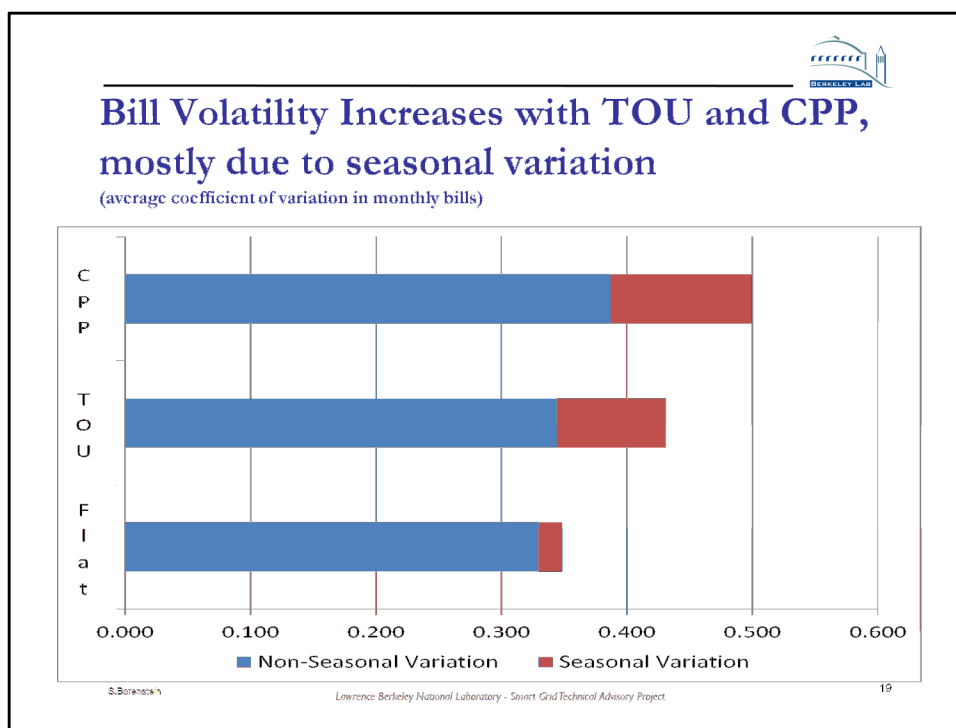
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This graph illustrates average bill impacts using income as the differentiating variable.

What this graph shows is that there is really very little relationship between income and the impacts of changing from a flat to CPP tariff. While the graph seems to show that the higher income segment (upper bar) would experience a reduced average bill, this is in fact due to regional differences – in California, higher income customers tend to live along the coast with cooler temperatures, which by itself generates reduced average bills.

Within a region higher income customers tend to pay more and lower income customers pay less.

None of these income impacts are statistically different from zero on average.



24:42

On the bill volatility issue there are two aspects related to dynamic that are important to address. One is predictable volatility, where dynamic pricing would impose higher prices in the summer than in the winter, when load peaks and prices are generally higher. In this example, predictable volatility is illustrated by the red portion of each bar. Switching from a flat annual rate to one that varies from summer to winter, you get much more volatility.

The non-seasonal or unpredictable variation does not go up very much.

When you switch from a flat to any rate form with seasonal variation, it is important to recognize that the seasonal changes in costs will drive much of the bill volatility in some cases more than the actual rate.



Impact of an opt-in CPP tariff under equitable pricing

- Impact on default flat-rate customers depends on who and how many opt in and how the dynamic prices change their load
- Simple calculation for a pretty bad case
 - Opt ins are drawn only from customers who would save at least \$1 per month
 - Random 1/3 of those customers opt in
 - No change to their consumption pattern
- Would raise flat rate by 1.92% to 0.163/kWh

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26:06

The last three slides assumed that every customer participated in a CPP tariff. Using the same data, we also evaluated what would happen if a truly volunteer opt-in option was provided; who would opt-in and what types of impacts might be expected?

Our assumptions on this analysis were as follows:

1. Only those customers that would be 'winners' or structural beneficiaries would participate. In other words participants would include only those customers with favorable load shapes, that would produce bill savings without any additional changes and then only 1/3 of those would opt-in.
2. Assume no change to the consumption pattern – in other words no price response.

Even with these assumptions, the flat rate for those who chose to not opt-in would only increase on average less than 2%. So you would not see a huge increase in the flat rate for those who do not opt-in. However these results do confirm that those that opt-in are in aggregate paying their cost and those that choose to not opt-in also pay their costs.



Dealing with Increasing-Block Pricing

- Serious transfers problem if IBP is not synchronized between flat and dynamic tariff
 - IBP must be in both or neither
- CPP can be designed with IBP, but it is complex
 - Example is PG&E TOU E-7 tariff
- Partial solution is to structure CPP as a revenue-neutral surcharge (at peak times) and rebate (at off-peak times) to the existing IBP: e.g. PG&E Smart Rate
 - Design surcharge/rebate to be revenue neutral if ALL customers joined
 - Then adjust default tariff to make up revenue shortfall from voluntary signup
 - Bill CPP as a separate program

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27:02

Increasing block pricing is a big issues. While it is perfectly possible to overlay critical peak or time varying pricing on top of increasing block pricing, this form of tariff is problematic , which I'll go into with the next slide. PG&E and several other utilities have these types of rates although they don't advertise them.

Basically the approach is to add a surcharge on peak periods and a discount on off-peak periods that on average net out to zero if everyone signs up for this rate. Those that choose to not sign up should be priced as a class, exactly like examples in the preceding slides.



Tariff structures whose time has passed (or never arrived)

- Increasing-block pricing (IBP)
- Multiple meters for different electricity uses
 - No cost basis, expensive meters and billing
- Peak time rebates
 - Problem with setting baseline and knowing it
 - Incentive to invest in energy efficiency for peak
 - Problem with incentives for non-qualifiers
 - Result is large “free rider” problem
 - PTR becomes a property right, hard to change

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28:21

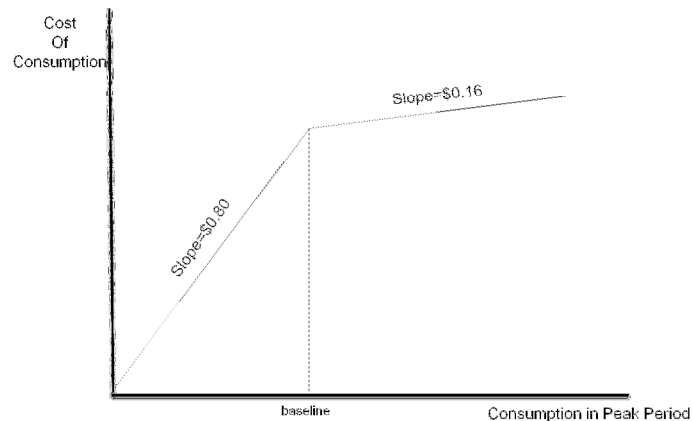
Increasing block pricing is a tariff whose time has passed. While I did not have the time to discuss this during the webinar, what I can say is that increasing block pricing does not reflect costs and there is no basic research or analysis to-date that shows it to be effective in promoting reduced energy usage. In fact, there is research that shows the lower price blocks tend to subsidize high users and in some cases encourage usage by low users.

Tariffs that require multiple meters for different electricity uses can provide competing signals to consumers, an example being an increasing block rate for a premise and low-cost off-peak rate to encourage storage or electric vehicle charging.

Peak time rebates have numerous problems outlined in the bullet points on this slide. Perhaps its primary weakness is a dependence on baseline computations. Implementation efforts in California are beginning to better expose free rider and other problems, which have been highlighted in recent rate proceedings at the CPUC. PTR baselines set based on previous consumption during peak periods create a disincentive to invest in efficiency measures or permanent peak load reductions. One is problematic for those without peak contributing loads. PTR, as a no loser rate, also tends to create a property right that may be very difficult to change.



One of the incentive problems under PTR: Non-linear price schedule



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29:36

One very important problem that is generally overlooked is the fact that PTR only applies to those that qualify for it. This graph represents a tariff schedule with PTR, where if you stay above your baseline, your marginal incentive is still very low price.

Conclusions

- Resistance to dynamic pricing based in part on uncertainty and appearance of inequity
 - Opt-in tariffs can reflect same costs for all
 - Shadow bills and phase-in can avoid surprises
 - Hedging and bill smoothing can reduce bad outcomes, but may distort behavior
- Transfer due to Mandatory CPP
 - Small number of big losers (6.7% increase by >20%)
 - Inland and heavy users lose, not poor
 - Easily offset if desired
- Opt-in tariff likely to raise default rate by <2%

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30:04

My conclusions:

- Resistance to dynamic pricing is based in part on uncertainty and appearances of inequity.
- Opt-in tariffs can overcome some of this and along with shadow bills, most of the uncertainty can be addressed.
- Phase-in, where the rates are set for both the opt-in and opt-out groups separately can smooth the transition and avoid large rate surprises.
- Finally, while hedging and bill smoothing can reduce bad outcomes, they tend to distort behavior and make future adjustments more difficult.
- Transfers due to mandatory CPP are among income groups are not very large and even among various usage groups, also are not particularly significant.

Questions:

- What about consumer subscription rates where the consumer chooses their own hedge. Response: this approach would not appeal to a very large group and it is too complicated. Even large C/I find this approach too complicated.
- How would an opt-in option work in a restructured market with retail choice. Response: Retail rates that don't reflect costs allow other providers to cherry-pick. Now under an opt-in pricing scheme, those lower users are seeing a more accurate cost and less likely to be cherry picked.
- Is there any risk premium for customers that don't opt-in to RTP? Response: No, there is no need for another risk premium. People that choose to not opt-in will already be paying a higher rate that reflects their true costs.



Smart Grid Transition Strategies: Crossing the Bridge to Time-of-Use Rates

Ron Binz

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35:22



Rate Structures and the Colorado PUC

- ☐ The Colorado PUC conducted a two-year investigation of rate structure issues.
- ☐ Outcome was a policy guidance decision, indicating future development of rate structures.
- ☐ The PUC required Xcel Energy to file options for inverted block rates as part of a rate case.
- ☐ PUC adopted seasonal inverted block rates for residential customers.

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36:02

Just prior to leaving the Colorado Commission April of this year. We had conducted a two-year investigation into rate structures issues, with the outcome being a policy guidance document that spoke to future development. One outcome was a requirement for the largest utility in the state to file options for inverted block rates which the Commission then adopted on a season basis.



	Current	Inverted Block Rates	Fixed Period Time of Use	TOU + Critical Peak	Real Time Pricing
Residential	Flat Energy Charge Seasonal	Default if no TOU meter	To Become Default if meter available	Optional	Not Available
Commercial	Flat Energy Charge Seasonal	Not Available	To Become Default if meter available	Optional	Not Available
Secondary General	Seasonal Demand Chg Flat Energy Chg	Not Available	To Become Default	Optional	Optional
Primary General	Seasonal Demand Chg Flat Energy Chg	Not Available	Not Available	To Become Default	Optional
Transmission General	Seasonal Demand Chg Indiv Fixed Chg	Not Available	Not Available	To Become Default	Optional

R.Binz

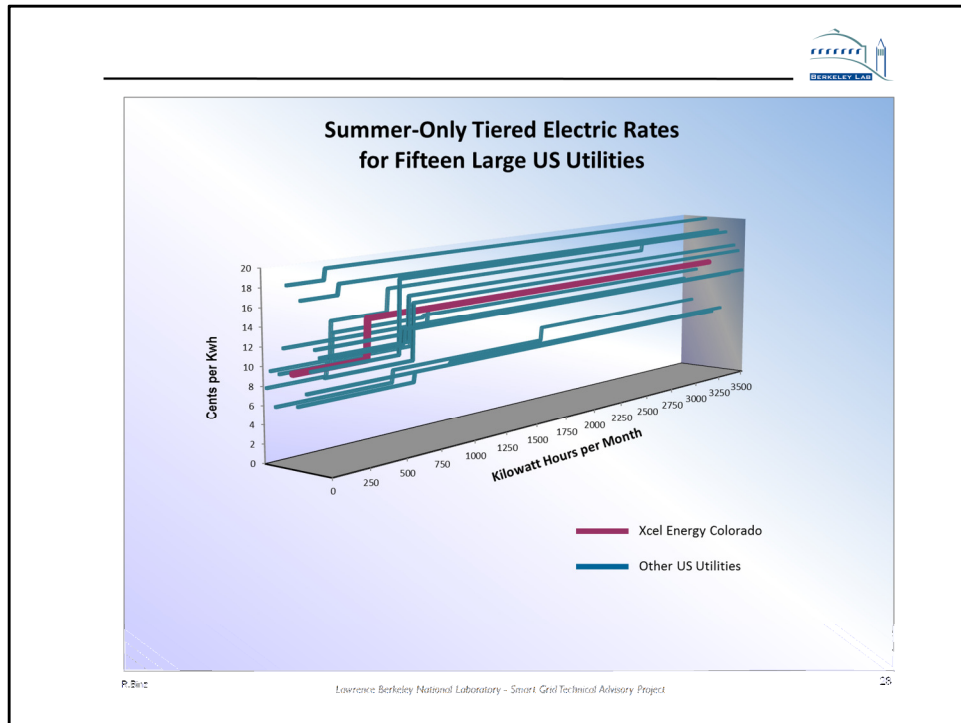
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36:27

This matrix was originally proposed to the Colorado Commission by Jim Lazar from the Regulatory Assistance Project. This matrix shows where the Colorado Commission is headed in its rate development efforts.

Residential class will progress from flat to season, to inverted block rates, and then as metering becomes available customers will migrate to TOU plus Critical Peak Pricing. This matrix shows every rate class and the possible rate structure plan. This development effort is not carved in stone, however, it does provide a signal to everyone involved with the regulatory community where the Commission is headed.



37:32

The wine colored line on this graph shows how the Xcel proposed seasonal inverted block rate compares with other similar proposals from around the country. This graph will be revisited later in the presentation as an example of how commission can / should announce proposed rate changes .



New Motivations for Dynamic Pricing

- ❑ Arrival of Electric Vehicles
 - Avoid early evening peak
 - Fill nighttime valleys
- ❑ Growth in Distributed Generation
 - Correctly value distributed generation
- ❑ Potential of New Energy Markets
 - Smart grid apps enabled
- ❑ Need for Residential Price Response
 - EE and DR

R.Bliz

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38:04

The new motivations for dynamic pricing is the arrival of electric vehicles. It will be important to avoid the early evening peak when Evs come on. It will be equally important to fill the nighttime valleys for a lot of utilities with substantial wind.

The growth in distributed generation is another justification for dynamic pricing, with rates that reflect the time-of-use differences. This will help to correctly value distributed generation.

There are also new energy markets that will enable customers to respond to prices and optimize the entire system. Current pricing does not enable smart grid. Without dynamic prices we have smart meters with dumb prices.

Finally, residential price response is another possibility .



Terminology

Flat Rates

- ☐ time-of-use insensitive
- ☐ includes inverted block rates
- ☐ includes seasonally differentiated flat rates

Dynamic Rates

- ☐ Time of Use Rates (TOU)
 - fixed prices in fixed time periods
 - includes seasonal differentiation
- ☐ Critical Peak Pricing (CPP)
 - higher prices during peak events
- ☐ Real Time Prices (RTP)
 - hourly prices

R.Binz

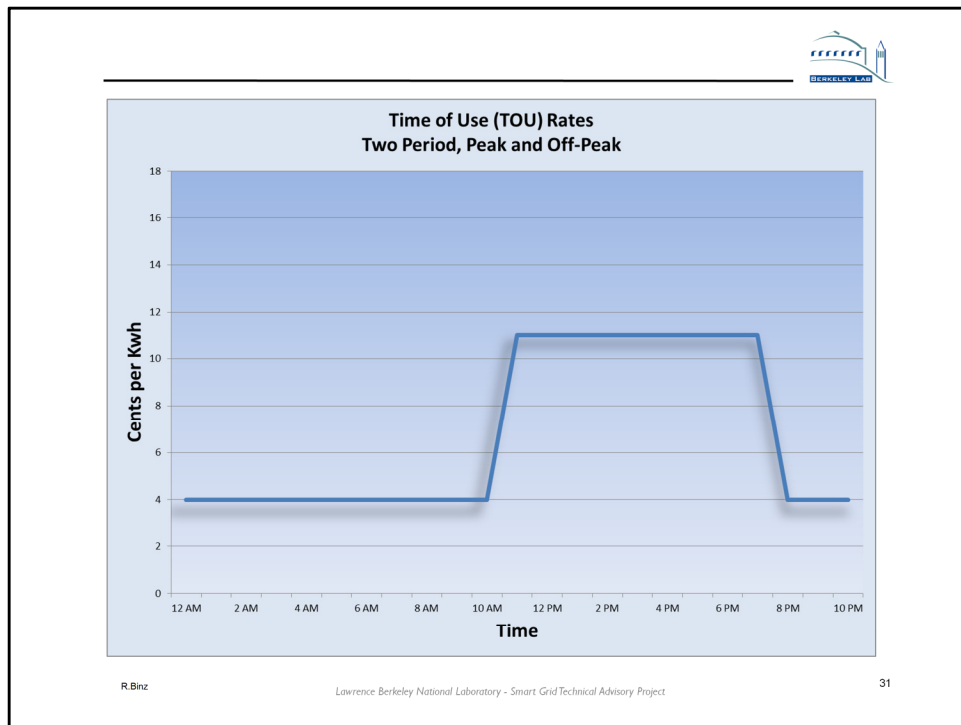
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39:51

This slide just identifies the terminology being used in the remainder of this presentation.

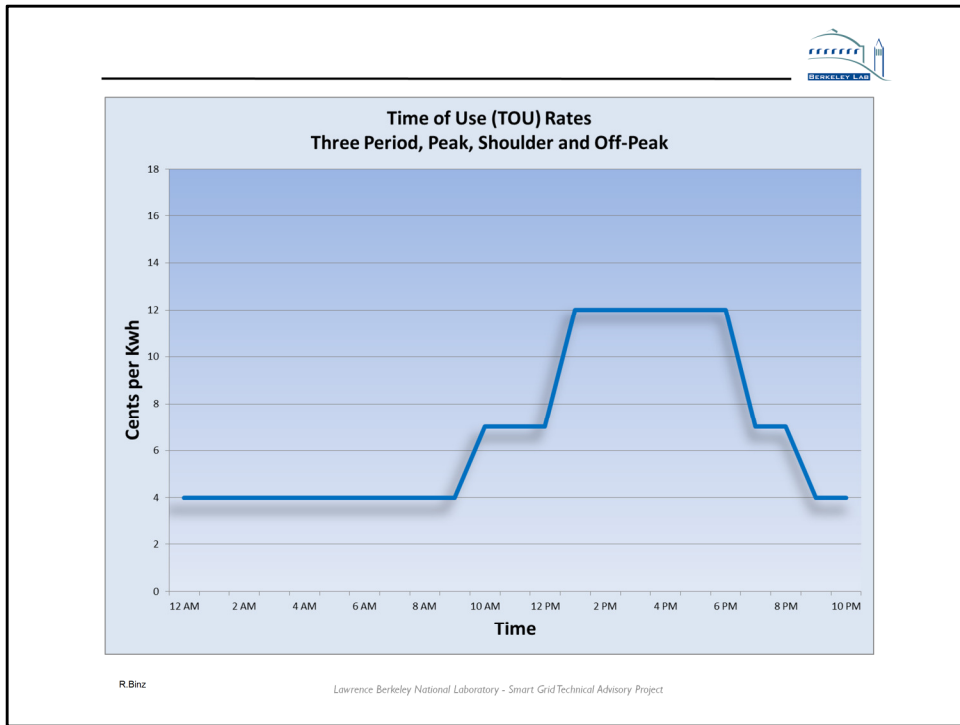
What I mean by dynamic rates include Time-of-Use rate which can have fixed prices in fixed time periods and may also include seasonal differentiation. Dynamic rates also include Critical Peak Pricing (CPP) and Real-Time Prices, which is higher prices during peak events which may occur only a few times each year, and (RTP) with hourly or sub-hourly prices to reflect system costs.



41:15

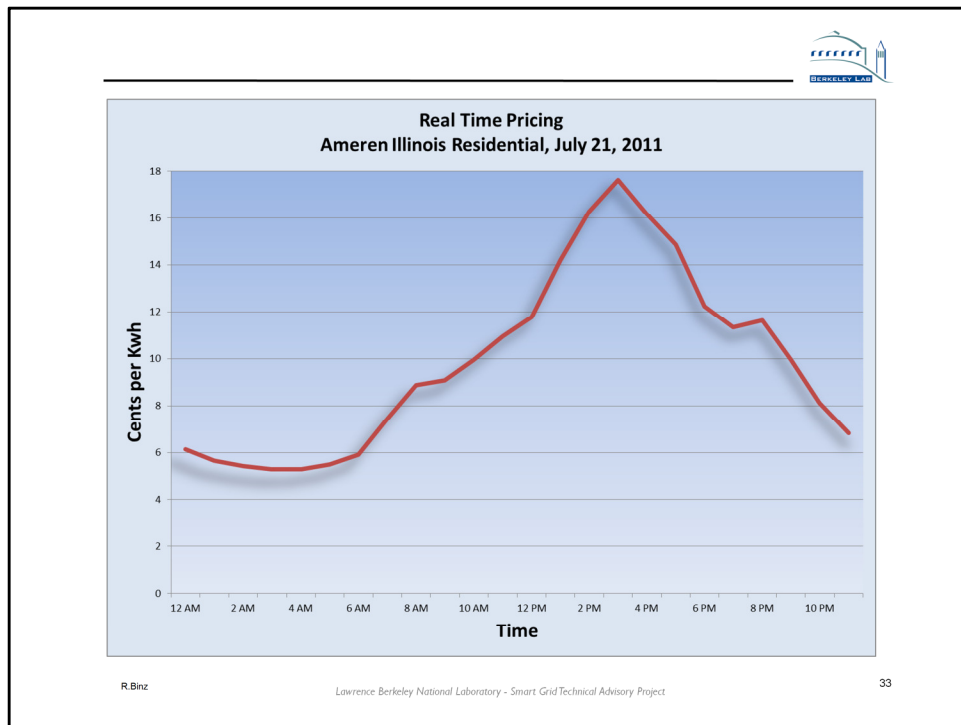
A few of the following slides provide examples of the various rate forms I've just defined.

This graph illustrates a two period TOU rate, one with a peak and an off-peak rates, two prices.



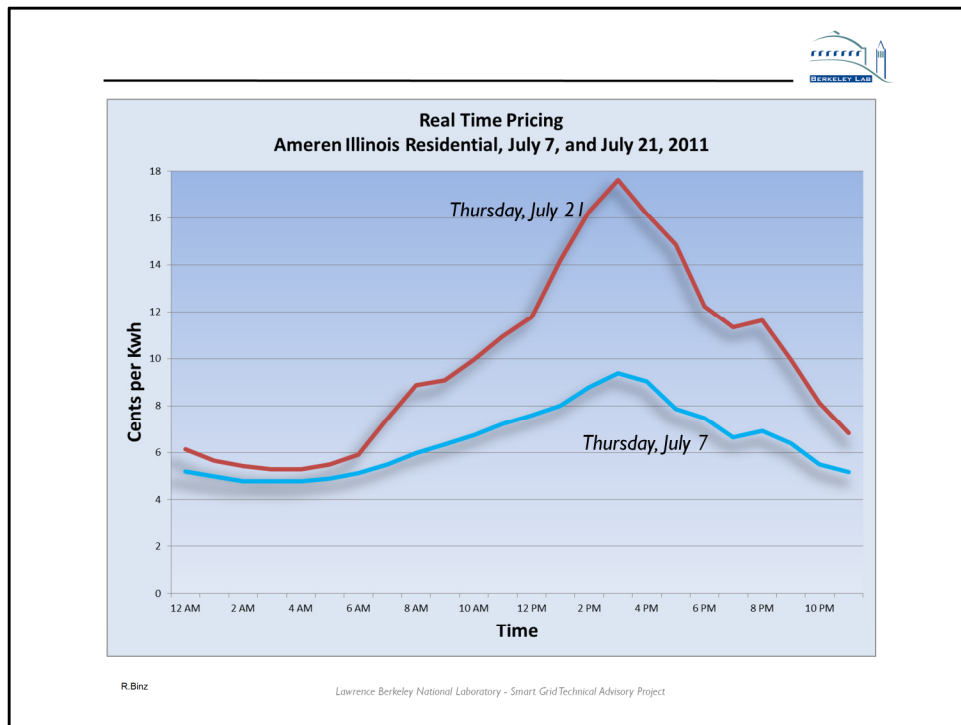
40:48

This graph represents a three period TOU rate, with a peak period from what appears to be 1:00pm to 7:00pm, a shoulder period which starts at 10:00am and goes to 1:00pm and an off-peak with runs through the late evening.



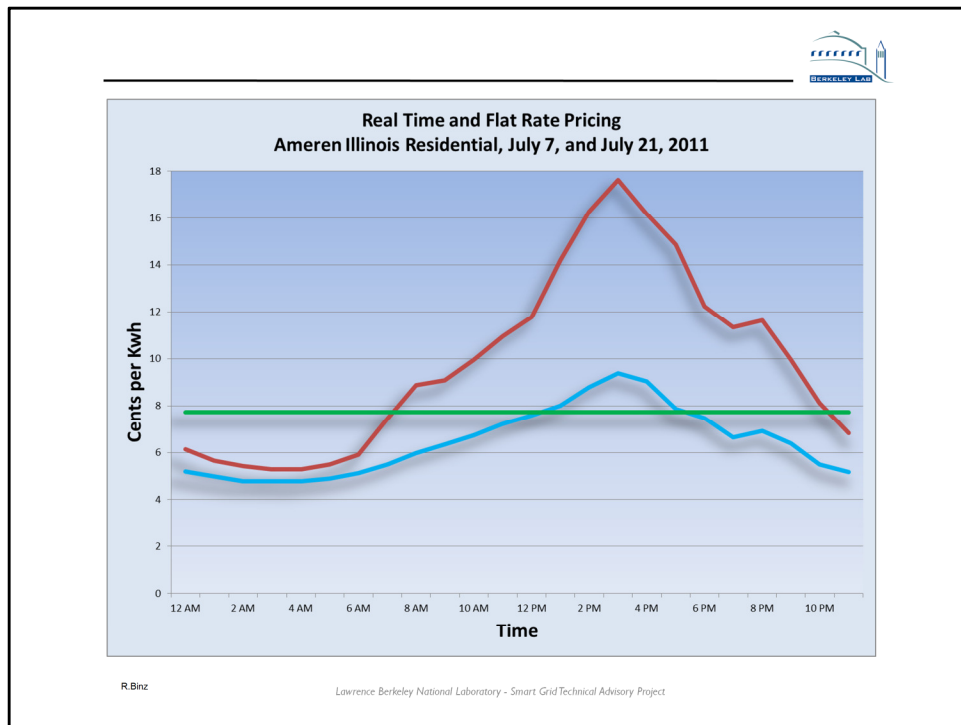
41:15

Contrast the prior two examples with this graph illustrates a dynamic rate. This graph actually represents the real time price of delivered electricity in Illinois on July 21st of this year. You can see that nighttime prices in the late evening and early morning fluctuated in the \$0.05 to \$0.06 / kWh range, which climbed steadily to a price of \$0.18 during the mid-afternoon peak at around 3:00pm. These prices include the deliver charge, which is what a residential customer might have experienced if they had a real-time rate.



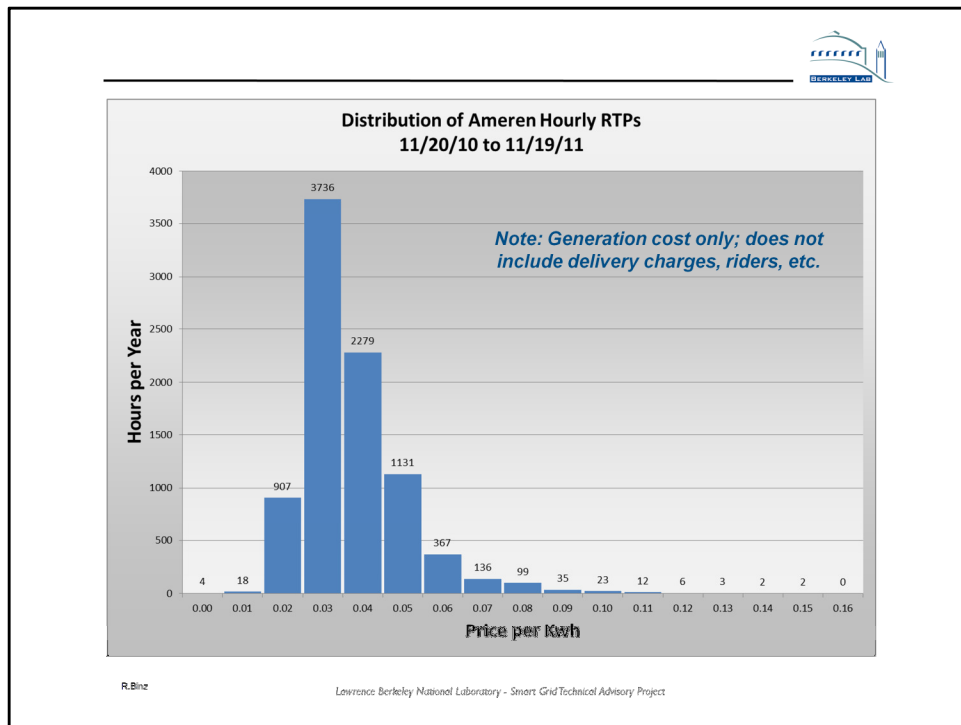
41:58

Now this is what happened two weeks before the July 21st example from the prior slide. On July 7th, both Thursdays, the system costs varied significantly particularly during the hours from 6:00am through the evening.



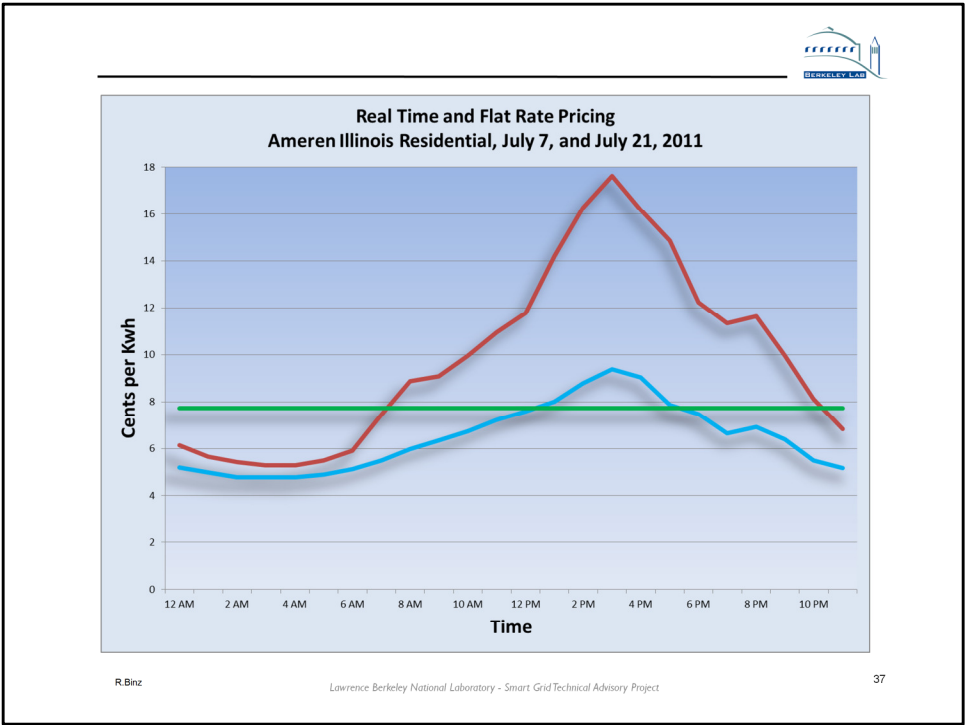
43:18

Ameren (Illinois) also offers for customers a flat rate which is about \$0.08/kWh for all hours in the day. The green line flat rate shows that customers on this rate would have paid substantially less for power during the peak hours addressed by the real-time price on either July 7th or July 21st, however they would have paid more through the off-peak hours. Peak prices on either of the July days from this a the prior graph illustrate both the incentives to shift load or reduce peak and opportunity costs of not doing so created by hourly varying prices.

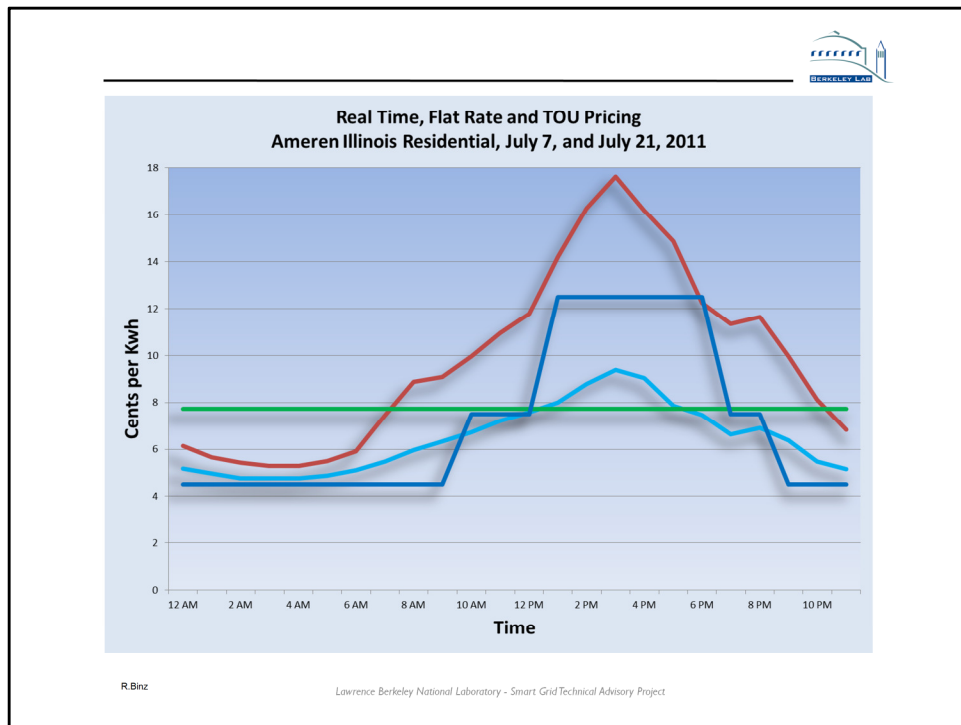


43:20

This is a distribution that shows the distribution of Ameren real-time prices/kWh on 8760 hours per year. For the vast majority of hours the prices fall between \$0.02 and \$0.06. This is generation only. Distribution of delivery costs are not included. There are only a few hours during the year. For example at there are only 13 hours per year (right tale) when the price equals or exceeds \$0.12 or more during the year. This graph illustrates the benefits and value that dynamic pricing, like CPP or RTP would add to the system over flat or inverted block prices.



44:47
This is a repeat of an earlier graph.



44:47

Overlaid on this graph is a plot of a three-part TOU rate .

My thesis is that the movement toward more dynamic prices requires a transition rate or ice-breaker that will encourage customers to migrate to TOU or dynamic prices. Regulators are concerned about moving customers to dynamic rate because of their concern for a customer push-back.

My thesis is that a TOU rate provides a transition step that as this graph illustrates, can capture most of the price variation inherent in a real-time price. For the remainder of my discussion, I am proposing that a TOU rate structure might be a superior approach and preferred rate structure for dynamic pricing.



The Sixty Four Dollar Question: TOU rates – optional or mandatory?

Optional

- ☐ Preserves choice for all customers
- ☐ High-cost customers will not switch
- ☐ Migration to TOU will take a long time
- ☐ Chicken and egg for Smart Grid apps

Mandatory

- ☐ Equitable if pricing is correct
- ☐ Likely to effect large system savings
- ☐ Opens large Smart Grid markets
- ☐ Likely to elicit consumer resistance

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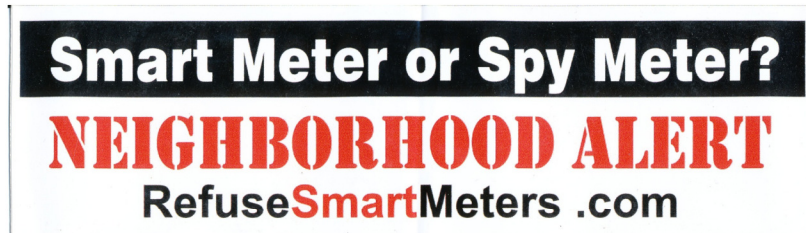
46:10

The sixty-four dollar question is – should TOU rates be optional or mandatory.

Severin made a good case of explaining the resistance to dynamic pricing and the potential value of an optional or opt-in rate. However, I have several observations that argue for a different approach, specifically:

1. optional preserves choice for all customers
2. Optional also means that the high-cost customers probably won't switch
3. If averaged into the pool of non opt-in customers, the high-cost customers will for quite a long time reap the benefit of flat rates rather than pay their true costs to the system
4. Switching customers into a dynamic rate on an opt-in basis may take a very long extended time period that limits the potential realization of system benefits and delays implementation of smart grid applications.
5. On a mandatory treatment, it is equitable if the pricing is correct. If system prices vary by time of day, then flat rate prices will forever wrong and won't be cost effective.
6. Mandatory will generate large system effects and consumer resistance.

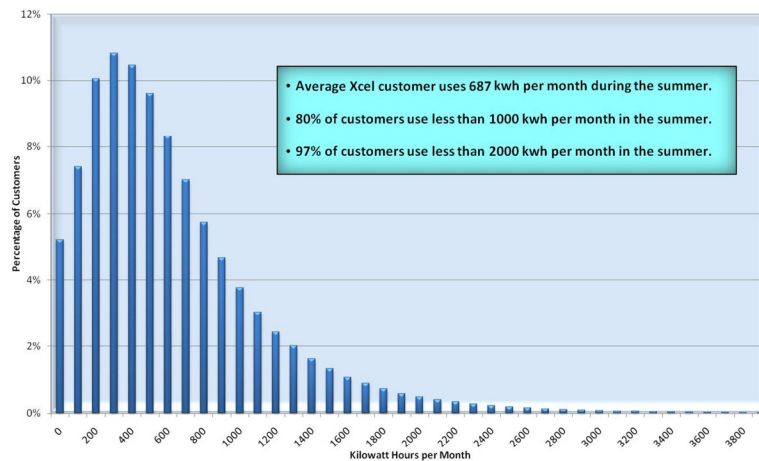
The Challenge of Smart Pricing



48:53

This bumper sticker evidences the deep felt resistance to meters and pricing.

Percent of Customers at Various Consumption Levels
Monthly Usage, Xcel Summer 2008



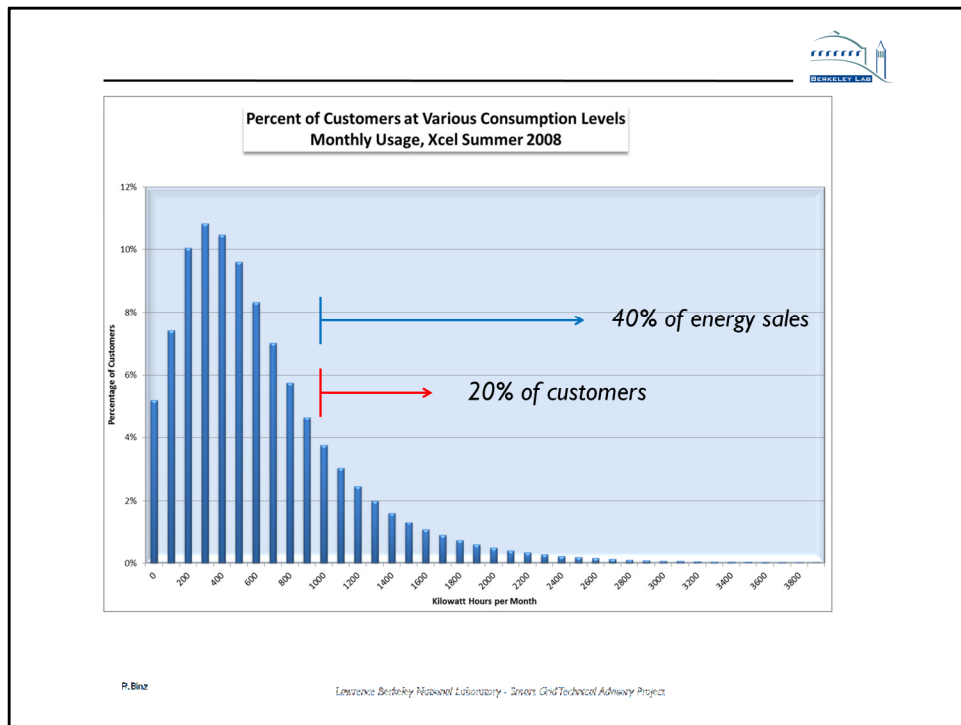
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48:55

This is a profile of the summer 2008 use of customers on the Xcel system. The distribution of usage is what is key. As the inset blot states, the while the average customer uses 687 kWh / month, 80% use less than 1000 kWh and 97% use less than 2000 kWh/month.



49:42

Using that same distribution, 20% of customers uses greater than 1,000 kWh in the summer but those same customers use 40% of all energy. This fact leads me to a basic observation and recommendation that I call the “Top 20”.



The “Top 20” Approach

- ☐ Make TOU rates mandatory for largest residential users (Top 20% of customers)
- ☐ If not already installed, target AMI meter installations to Top 20
- ☐ Make TOU rates available optionally for all other customers with AMI meters
- ☐ Incorporate Top 20 into AMI roll-out strategies

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50:00

Make a three-period TOU rate mandatory for the largest “Top 20%” of residential customers. The 20% number is not magic, you could use any number you wish, however I’ll start with 20%. If not already installed, advanced metering infrastructure (AMI) would be targeted to these customers if not already installed. TOU or other dynamic rates could be offered optionally for all other customers that have AMI meters.



Advantages of Top 20 Approach

- ☐ Will not be seen as unfair; consumer resistance less likely
- ☐ Will apply to approximately 40% of sales
- ☐ Largest users likely higher income
 - more likely to purchase EVs
 - more likely to purchase in-home devices
 - more likely to add distributed generation
- ☐ Largest users likely AC users
- ☐ Payoff will be greatest for meter investment
- ☐ Will “socialize” TOU rates
 - will “break the ice” for dynamic pricing
 - will encourage additional opt-in for smaller customers

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51:01

There are many advantages to this approach.

- I do not think this approach will be considered unfair.
- It will apply to a large fraction of kWh sales
- The largest users will be picked up under this approach, these customers are most likely to be purchasers of electric vehicles, smart appliances and best candidates for solar and other forms of distributed generation
- These customers are also the most likely users of AC
- A mandatory approach with these customers will generate the greatest benefit and payoff for any meter investment
- Working with these customers may also socialize the rollout of dynamic rates and encourage opt-in for smaller customers.



Cost Allocation/Rate Design Choices

- ☐ Set Top 20 (or Top 15) revenue requirement initially equal to existing revenues
- ☐ Use two-period or three-period TOU rates
- ☐ Make choices for time periods
- ☐ Make choices for peak-shoulder-off peak ratios
 - can change over time
- ☐ Optionally add a CPP element
- ☐ Optionally use seasonal price differentiation
- ☐ If necessary, use “shadow pricing” for one year

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53:16

There are a number of choices for addressing cost allocation in rate design to support this recommended Top 20 approach.

- One option is to set the revenue requirement for the target group (top 20 or even top 15 percent of the consumers) equal to their existing revenue requirement . This makes the change a revenue neutral shift.
- How many time periods to include in the TOU rate is a judgment call.
- Time periods are also a judgment call.
- The peak to off-peak ratios can be whatever you want them to be, considering what the level of acceptance might dictate.
- Optionally CPP and seasonal differentials could be added.
- Optionally , shadow pricing could also be considered.



Justification

- ❑ TOU rates are cost-based; flat rates are not.
- ❑ Large residential customers are qualitatively different
 - Benefit/cost ratio much greater since metering costs are relatively smaller
 - High correlation with air-conditioning load
- ❑ We distinguish commercial customers by size today
 - Small commercial rates often flat; medium commercial are usually billed under demand/energy rate structure
- ❑ Need to prepare for EVs
 - Large users likely to be first EV owners
 - Impractical to separately meter and bill for EVs
- ❑ Can be a pricing “trial” that may or may not be extended to smaller customers

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54:57

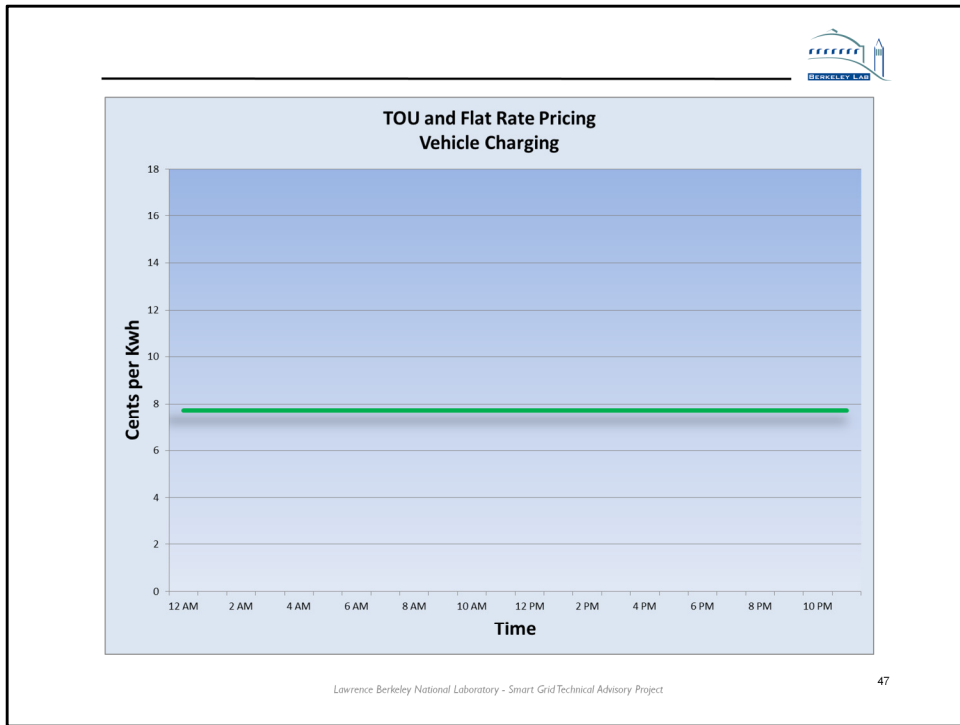
The justification for this approach is that TOU rates are generally cost based, while flat rates are not.

Large residential customers are qualitatively different and the cost benefit ratio for them should be much higher for justifying metering costs and this group will most likely have much higher air conditioner ownership, which not only contributes to summer peak loads but also justifies potential automation initiatives for controlling this load.

Regulatory practice today already distinguishes customers by size – particularly in the commercial and industrial class. We have discriminated between customers in the commercial class relative to decisions on metering and rates because it makes sense. These decisions go back to the original PURPA legislation in the mid 1970's.

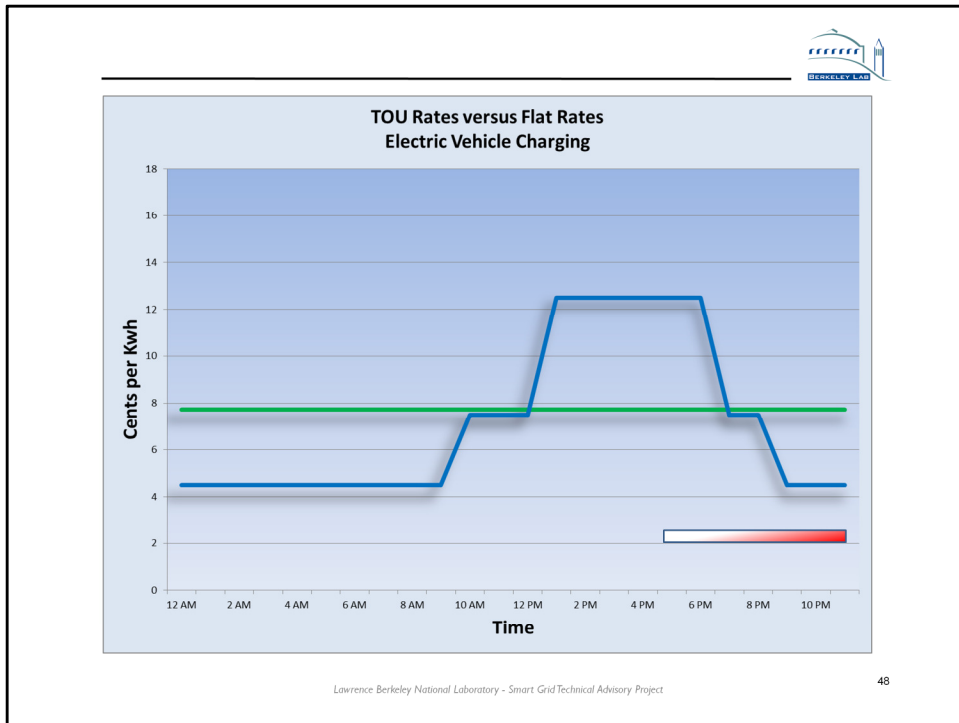
Furthermore, we need to prepare for EV implementation. Targeting the large users makes sense because they will also be the most likely first-purchasers of Evs.

Finally, if policies to target large residential users is problematic or if commissions need additional justification, then this approach can be structured and considered to be a pricing trial that may or may not be extended to smaller customers.



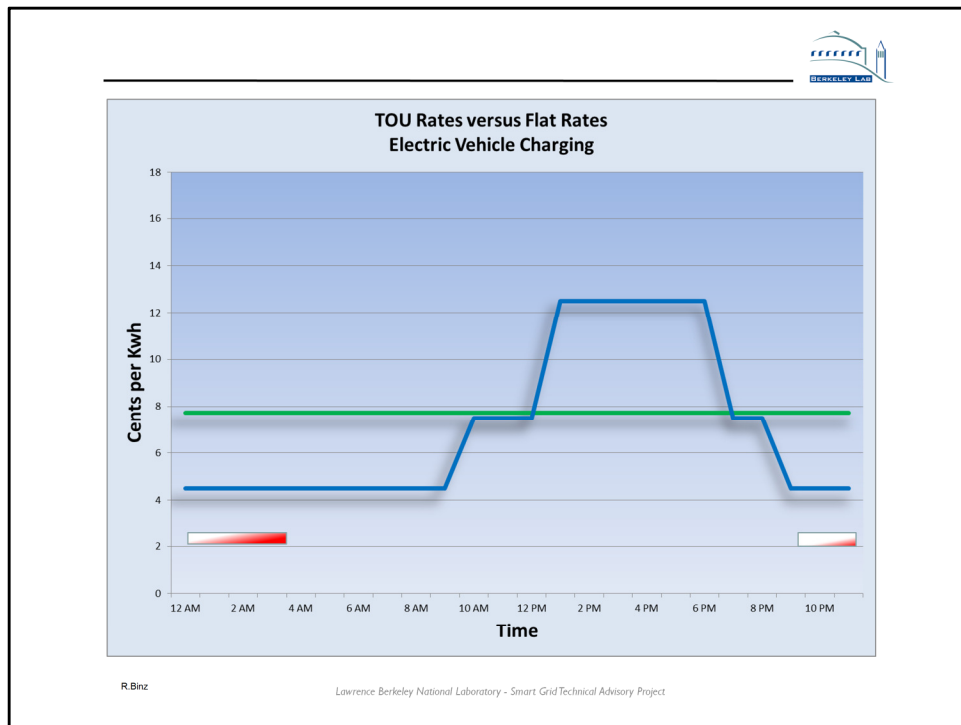
58:05

Just to nail down the EV part, this graph represents what a flat rate looks like.



56:54

This is what a TOU rate would look like. Superimposed on this graph is the red bar on the bottom right which represents the logical charging strategy for a potential EV. Unfortunately, the charging time starts during the peak. Without the TOU rate this strategy would prove costly.



57:42

The TOU rate would incentivize the customer to defer charging to later hours which would avoid contributing to peak load, help fill the off-peak valley, and prove very economically beneficial to the customer.

Conclusions

- ☐ Regulators should develop and announce a pricing strategy
- ☐ Communicate plan to consumers
- ☐ Use Top 20 (or Top 15) to introduce TOU rates without further commitment
- ☐ Keep initial TOU rate structure simple
- ☐ Move in logical steps on revenue requirements and pricing differentials for TOU customers.

58:07

My conclusions.

- ☐ Regulators should develop and announce a pricing strategy
- ☐ Communicate plan to consumers
- ☐ Use Top 20 (or Top 15) to introduce TOU rates without further commitments to other segments of the customer class.
- ☐ Keep initial TOU rate structure simple but some aspect of mandatory makes sense.
- ☐ Move in logical steps on revenue requirements and pricing differentials for TOU customers.



Questions and Answers

- ❑ Question for Ron Binz: With the top 20 approach, what do you think the metering costs ranges per point would be and wouldn't you be foregoing the operational savings from system wide AMI implementation?
- ❑ Reply: The Top 20 approach should not slow up the implementation of AMI. There are a number of strategies to implement AMI. This Top 20 approach just provides commissions with one alternative for further justifying the AMI investment.



Questions and Answers

- Question for Ron Binz: You've recommended TOU rates for smart grid, however TOU is a static rate that does not support advanced forms of demand response. Why not take the same approach for implementing a dynamic rate?
- Response: That alternative is also feasible. My recommendation was an attempt to address the political will of commissioners and better manage the potential push back from customers. Many customers and commissioners might be concerned about dynamic pricing. My recommendation was intended to capture a large fraction of the benefits of dynamic pricing while breaking the ice and starting the conversation. I'm not opposed to making RTP available on an optional basis, however I think reasonable options need to be more closely tied to approaches more familiar to the customer .



Questions and Answers

- ❑ Question for Severin Borenstein: You've recommended shadow bills to keep customers informed, however it wasn't clear whether shadow bills should precede the introduction of the CPP rate as an educational or engagement option or something to just accompany the rate introduction.
- ❑ Response: I would definitely use it to precede the introduction of the rate if the data were available. I would want to do it on a 12 month basis to capture the seasonal effects. I can also imagine a utility saying that on January 1st you'll have this option. We've done the calculation and if you had been on this rate you would have (a) paid \$5 more for the year or (b) saved \$25 for the year.

I want to emphasize that once the program / rate starts, customers should continue to get shadow bills regardless of which rate they are on so they are always informed. Credibility is very important. Asymmetric information that has any appearance of biasing information in any direction undermines credibility and increases suspicion regarding utility motives.



Questions and Answers

- ❑ Question for Severin Borenstein: What sort of time frame would be required to achieve any significant opt-in to a target rate? Do you have any research to guide this response?
- ❑ Response: I wish I know more. There is no formal research to help guide this response. I think much would depend upon how much information you could provide to customers and think shadow bills would help facilitate this effort. Shadow bills requires that all customers have advanced meters. With the advanced meters utilities can tell their customers that we've been collecting your interval data and now we can tell you exactly how you would have done on this rate. We haven't had the meters installed on everyone, so the capability to use shadow bills in this way has not been available before. We would expect that many of the customers, maybe half might even be told that you would have saved money even if you had done nothing. We also have to address bill volatility and tell customers that during peak times you'll face a higher price and may face a higher bill. I think this type of information might engender a higher positive response to the rate offering. In past marketing efforts customers have been provided with no information regarding potential impacts. So I would expect better information would increase participation, however I have no information to indicate how much more.

Questions and Answers

- ❑ Question for Severin Borenstein and Ron Binz: Both presentations use different approaches that attempt to minimize or mitigate potential customer revolts. Severin's approach is to use opt-in while Ron's approach mandates targeted to a small segment of the customer class. There are downsides to both approaches. Opt-in runs the risk of undermining the advanced meter business case because it will most likely produce no initial price response. The mandatory approach could also elicit some strong resistance even though it applies to a small segment of the customer market. Both of you seem to agree that shadow bills provide a constructive approach. Shadow bills also provide regulators and utilities with how the rate will impact each individual customer. **Why not pursue an opt-out approach combined with a pro-active approach that targets them for more education or movement to a safe rate?**

- ❑ Response:

Severin – If you take a class of people and move them to a safe rate that covers their costs, which is priced as I've recommended, then approximately half of those customers will be better off not being in that group and paying their cost directly. You could do a sort based on volatility rather than level, however in any case customers moving to a safe rate will wind up paying more because they will be in a higher cost pool. So I don't think we should be actively marketing that we will be protecting customers but I do think target marketing has some merits. I've been working on this since 2001 and initially pursued the alternative mandatory and opt-out approaches, however there is still hardly any time-differentiated or dynamic pricing in the residential class. So I agree with Ron that there is value in breaking the ice and getting the ball rolling is important.

Ron – I agree with Severin. Under my proposal I would not permit opting-out. That would put high-use customers into the other pool, raising costs for all of those customers. I'm concerned that the averaging that goes on in a default pool might be a real impediment to the movement toward cost-based pricing. There are many firms waiting to market their products but they need the high-use customer pool to create the market.



Questions and Answers

- ❑ Question for Severin Borenstein and Ron Binz: What can be done to motivate utilities under an opt-in approach to encourage utilities to improve their marketing to achieve meaningful enrollment levels?

- ❑ Response:

Severin: Ron, you're going to have to take this one. I have not dealt with these issues of utility marketing. Enough regulatory pressure can move utilities to accomplish most objectives.

Ron: This is the same barrier that we face with energy efficiency. You're asking utilities to find customers that will save money by moving to another rate class. Utilities will do this, however they will want compensation to adjust for lost revenues. We haven't talked about the revenue issue and how you keep the utility from being the loser on these initiatives. It is possible that a switch from a flat rate to dynamic rate may induce behavior change and impact the cost of service. It is more likely that the intermediaries will take up the marketing effort.



Questions and Answers

- ❑ **Question:** In a private exchange between participants via text messaging, Ben Stafford from the Ohio Commission asked a question to Pete Cappers* inquiring as to the status of the ARRA funded Consumer Behavior Pilots and when results might be available.
- ❑ **Response:** Pete said that most pilots are just starting and results will most likely not be available for at least 1-2 years. Ten of those pilots have some form of recruitment designs that cover the spectrum of utility options.

* Peter Cappers works for the Lawrence Berkeley National Laboratory. As one of his responsibilities he functions as the coordinator for the Technical Advisory Groups overseeing the ARRA projects.



Questions and Answers

1:18:28

- Question for Severin Borenstein: Your next to last slide seemed to address the expectation of customers receiving rebates. Could you address that point as well as how utilities can manage changes in customer baselines.
- Response: My quick answer is don't do peak time rebates (PTR). I really think that PTR rebates are a bad policy. Some people have argued that PTR is a good transition strategy for moving to more dynamic rates. I think just the opposite, that PTR convinces people they have a right to be paid to reduce. PTR will just make it much harder to change the system and convince customers that this is what power costs and this we have to charge more at certain times. PTR may just be a trap that will be much harder to get out of once you get into it. You could get around the baseline issue by just adopting an exogenous baseline that is unrelated to the individual customer usage, say for a neighborhood. However, the problem with this approach is that it creates a huge free-rider problem. If the baseline is not well calibrated you'll wind up paying for a lot of reduction that is not real. There is only one natural baseline and that is zero. If you don't use any electricity, you don't have to pay for it.



Questions and Answers

1:20:27 Comment - Chuck Goldman: This discussion has presented two innovative models for thinking about transitioning to dynamic pricing depending on where the commissions are with their utilities. If you are already doing full scale AMI rollout, then Severin's approach may overcome some of the political opposition. If your utilities are not rolling out AMI any time soon and the business case is not going anywhere, then Ron's approach for targeting a segment of customer based on costs and usage patterns may be an attractive option for creating a market for services and innovation.

The challenge is to understand where your utilities are in the business case for AMI. The hidden or unpublicized agenda in this whole conversation is that while we are talking about TOU and dynamic pricing, most of the commissions are looking seriously at PTR as their chosen path.

Ron Binz: PTR taps so little of the retail side of smart grid.

Severin Borenstein: It is unfortunate that PTR has gotten so much traction. I think everyone looks at PTR as a free lunch when in reality it has to be paid for and that just means that rates are higher on average that just does not reflect costs.

Contact Information



- ☐ **Chuck Goldman**
Lawrence Berkeley National Laboratory
CAGoldman@lbl.gov
510 486-4637
- ☐ **Roger Levy**
Smart Grid Technical Advisory Project
RogerL47@aol.com
916 487-0227
- ☐ **Severin Borenstein**
E.T. Grether Professor of Business Administration and Public Policy,
Haas School of Business
borenste@haas.berkeley.edu
510-642-3689
- ☐ **Ron Binz**
Principal, Public Policy Consulting rbinz@rbinz.com
720-425-3335